

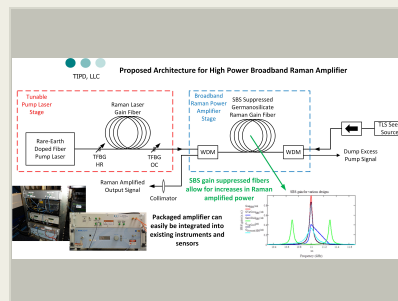
Broadband Fiber Raman Power-Amplifier for Narrow Linewidth Tunable Seed Lasers Used in Spectroscopic Sensing, Phase I

Completed Technology Project (2014 - 2014)



Project Introduction

We propose an energy and space efficient high power continuous wave (cw) narrow linewidth broadband fiber Raman amplifier (FRA) with spectrally tunable multi-Watt-level average power output in the near and shortwave infrared (1080 – 2000 nm) that can be used in remote sensing systems on both atmospheric and terrestrial space-borne platforms. The all-fiber amplifier design concept for power amplification of a lower power commercially available tunable laser seed source (master oscillator) uses a single gain stage architecture based on germanosilicate (GeO₂-SiO₂) fibers specifically designed to suppress stimulated Brillouin scattering (SBS), one of the main factors limiting the maximum output power from narrow linewidth cw fiber amplifiers. The amplifier will be pumped by a fiber Raman laser whose spectral output can be tuned by compressive fiber Bragg grating technology. For this proposal TIPD will demonstrate power levels beyond what has been previously demonstrated for this technique, necessary for pumping the SBS suppressed gain fiber amplifier stage to its maximum potential output power. By implementing techniques for suppressing SBS in highly doped germanosilicate fibers it is anticipated that the amplifier wall-plug efficiency will reach 10%. In addition, the single gain stage architecture is compatible with distortion-free amplification of a phase/amplitude modulated seed source, useful for sensors that rely on sophisticated signal processing for detection. During Phase I, we will validate the broadband FRA proof-of-concept through modeling and benchtop demonstrations of both the power amplifier and tunable pump laser stages. Furthermore, appropriate designs for both the tunable laser source and SBS suppressed germanosilicate gain fibers will be formulated and assessed in terms of performance that best meets the target technical specifications for the FRA for a potential Phase II effort.



Broadband Fiber Raman Power-Amplifier for Narrow Linewidth Tunable Seed Lasers Used in Spectroscopic Sensing Project Image

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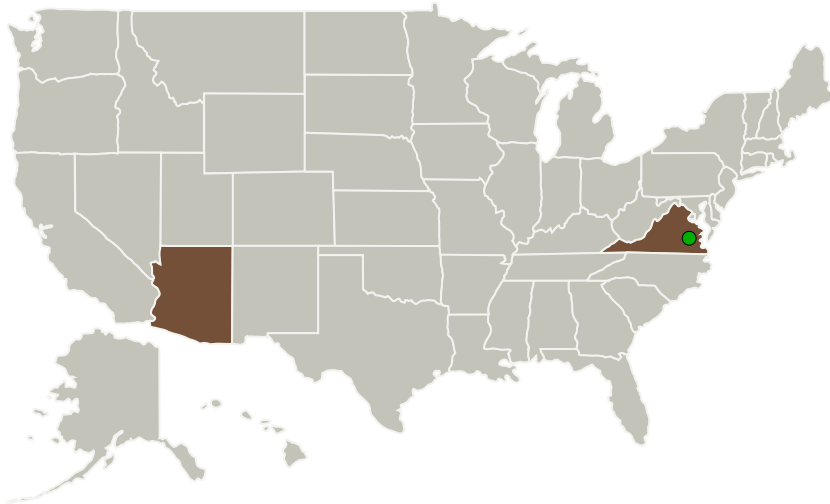
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
TIPD, LLC	Lead Organization	Industry	Tucson, Arizona
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Arizona	Virginia

Project Transitions

June 2014: Project Start

December 2014: Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/137778>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

TIPD, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

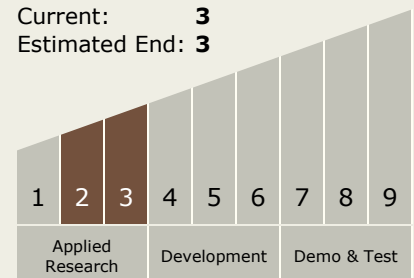
Carlos Torrez

Principal Investigator:

Valery Temyanko

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Completed Technology Project (2014 - 2014)

Figure 1: Proposed Architecture for High Power Broadband Raman Amplifier

The diagram illustrates the proposed architecture for a high-power broadband Raman amplifier. The system is divided into several functional blocks:

- Input Pumps:** The system is powered by three main laser sources: a **Raman Laser** (1550 nm), a **Raman Pump Laser** (1450 nm), and a **Raman Seed Laser** (1550 nm).
- Waveguide and Isolator Section:** The Raman Laser and Raman Pump Laser outputs are combined and pass through a **Waveguide** and an **Isolator** before entering the **Raman Amplifier**.
- Raman Amplifier:** This central component is responsible for amplifying the Raman signal. It includes a **Waveguide** and an **Isolator**.
- Output and Monitoring:** The amplified signal is output from the **Raman Amplifier** and passes through a **Waveguide** and an **Isolator** before being sent to the **Output**. A **Photodiode** is used for monitoring the output signal.
- Photodiode and Signal Processing:** The photodiode output is connected to a **Signal Processing** block, which generates a **1550 nm suppressed filter** and a **1450 nm suppressed filter**.
- Photodiode and Signal Processing:** The photodiode output is connected to a **Signal Processing** block, which generates a **1550 nm suppressed filter** and a **1450 nm suppressed filter**.

The photograph on the left shows the physical implementation of the Raman amplifier, which is a compact, rectangular device with various ports and a label.

The graph on the right shows the **Raman signal spectrum**, which is a plot of power versus wavelength. It features a prominent peak at 1550 nm, with smaller peaks at 1450 nm and 1550 nm. The x-axis is labeled **Wavelength (nm)** and ranges from 1400 to 1600. The y-axis is labeled **Power (dBm)** and ranges from -10 to 10.

Packaged amplifier can easily be integrated into existing instruments and systems

(<https://techport.nasa.gov/image/129860>)

- TX08 Sensors and Instruments
 - └ TX08.3 In-Situ Instruments and Sensors
 - └ TX08.3.1 Field and Particle Detectors

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System